

CLAIMS

What is claimed is:

1. A charge pump circuit comprising:
charge pumping capacitance;
5 switches that vary voltage across the pumping capacitance to provide a pumped output voltage from an input voltage;
variable resistance; and
control that varies the variable resistance with varied operating point.
- 10 2. A charge pump as claimed in claim 1 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.
3. A charge pump as claimed in claim 1 wherein the variable resistance comprises a switch coupled in parallel with a resistor.
- 15 4. A charge pump as claimed in claim 3 wherein the switch is a field effect transistor.
5. A charge pump as claimed in claim 3 wherein the control comprises a
20 comparator.
6. A charge pump as claimed in claim 3 wherein the control comprises an amplifier.
- 25 7. A charge pump as claimed in claim 3 wherein the control comprises a shunt reference device.
8. A charge pump as claimed in claim 1 wherein the variable resistance
30 comprises a field effect transistor.

9. A charge pump as claimed in claim 1 wherein the control comprises a comparator.
- 5 10. A charge pump as claimed in claim 1 wherein the control comprises an amplifier.
11. A charge pump as claimed in claim 1 wherein the control comprises a shunt reference device.
- 10 12. A controller comprising:
charge pumping capacitance;
switches that vary voltage across the pumping capacitance to provide a pumped output voltage from an input voltage;
variable resistance; and
15 control that varies the variable resistance with varied operating point.
13. A controller as claimed in claim 12 comprising both a charge pump internal to a controller integrated circuit and an external charge pump.
- 20 14. A controller as claimed in claim 12 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.
15. A controller as claimed in claim 12 wherein the variable resistance comprises a switch coupled in parallel with a resistor.
- 25 16. A controller as claimed in claim 15 wherein the switch is a field effect transistor.
17. A controller as claimed in claim 15 wherein the control comprises a
30 comparator.

18. A controller as claimed in claim 15 wherein the control comprises an amplifier.

5 19. A controller as claimed in claim 15 wherein the control comprises a shunt reference device.

20. A controller as claimed in claim 12 wherein the variable resistance comprises a field effect transistor.

10

21. A controller as claimed in claim 12 wherein the control comprises a comparator.

15

22. A controller as claimed in claim 12 wherein the control comprises an amplifier.

23. A controller as claimed in claim 12 wherein the control comprises a shunt reference device.

20

24. A DC/DC converter comprising:
controlled switches; and
a controller that controls the controlled switches, the controller comprising:

25

charge pumping capacitance;
switches that vary voltage across the pumping capacitance to
provide a pumped output voltage to the controller from an input voltage;
variable resistance; and
control that varies the variable resistance with varied operating
point.

30

25. A DC/DC converter as claimed in claim 24 comprising both a charge pump internal to a controller integrated circuit and an external charge pump.
- 5 26. A DC/DC converter as claimed in claim 24 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.
27. A DC/DC converter as claimed in claim 24 wherein the variable resistance comprises a switch coupled in parallel with a resistor.
- 10 28. A DC/DC converter as claimed in claim 27 wherein the switch is a field effect transistor.
29. A DC/DC converter as claimed in claim 27 wherein the control comprises a comparator.
- 15 30. A DC/DC converter as claimed in claim 27 wherein the control comprises an amplifier.
31. A DC/DC converter as claimed in claim 27 wherein the control comprises a shunt reference device.
- 20 32. A DC/DC converter as claimed in claim 24 wherein the variable resistance comprises a field effect transistor.
- 25 33. A DC/DC converter as claimed in claim 24 wherein the control comprises a comparator.
34. A DC/DC converter as claimed in claim 24 wherein the control comprises an amplifier.
- 30

35. A DC/DC converter as claimed in claim 24 wherein the control comprises an shunt reference device.
- 5 36. A method of charge pumping comprising:
varying voltage across a pumping capacitor to provide a pumped output voltage from an input voltage; and
varying variable resistance in circuit with the pumping capacitance with varied operating point.
- 10 37. A method as claimed in 36 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.
38. A method as claimed in 36 wherein the variable resistance comprises a field effect transistor.
- 15 39. A method as claimed in 36 wherein the variable resistance is varied in response to a comparator.
40. A method as claimed in 36 wherein the variable resistance is varied in response to an amplifier.
- 20 41. A method as claimed in 36 wherein the variable resistance is varied in response to a shunt reference device.
- 25 42. A method of converting DC voltage to DC voltage comprising:
varying voltage across a pumping capacitor to provide a pumped output voltage from an input voltage;
varying variable resistance in circuit with the pumping capacitance with varied operating point;
- 30 applying the output voltage to a controller; and

controlling converter switches from the controller.

43. A method as claimed in 42 wherein the variable resistance is coupled in series with the pumping capacitance and input voltage.

5

44. A method as claimed in 42 wherein the variable resistance comprises a field effect transistor.

45. A method as claimed in 42 wherein the variable resistance is varied in response to a comparator.

10

46. A method as claimed in 42 wherein the variable resistance is varied in response to an amplifier.

47. A method as claimed in 42 wherein the variable resistance is varied in response to a shunt reference device.

15

48. A charge pump comprising:
means for varying voltage across a pumping capacitor to provide a pumped output voltage from an input voltage; and
means for varying variable resistance in circuit with the pumping capacitance with varied operating point.

20

49. A controller comprising:
means for varying voltage across a pumping capacitor to provide a pumped output voltage from an input voltage; and
means for varying variable resistance in circuit with the pumping capacitance with varied operating point.

25

30

50. A DC/DC converter comprising:
- means for varying voltage across a pumping capacitor to provide a pumped output voltage from an input voltage;
 - means for varying variable resistance in circuit with the pumping
- 5 capacitance with varied input voltage;
- means for applying the output voltage to a controller; and
 - means for controlling converter switches from the control.